

ISSN 2278-4136
JPP 2014; 3 (2): 89-94
Received: 15-06-2014
Accepted: 23-06-2014

Hina Rehman

Department of Ilmul Qabalat wa Amraze
Niswan (Obstetrics and Gynaecology),
National Institute of Unani Medicine,
Bangalore, Karnataka, India

Wajeעה Begum

Department of Ilmul Qabalat wa Amraze
Niswan (Obstetrics and Gynaecology),
National Institute of Unani Medicine,
Bangalore, Karnataka, India

Farzana Anjum

Department of Ilmul Qabalat wa Amraze
Niswan (Obstetrics and Gynaecology),
National Institute of Unani Medicine,
Bangalore, Karnataka, India

Humyra Tabasum

Department of Moalejat (Medicine),
National Institute of Unani
Medicine, Bangalore, Karnataka,
India.

Correspondence:**Hina Rehman**

Department of Ilmul Qabalat wa
Amraze Niswan (Obstetrics and
Gynaecology), National Institute of
Unani Medicine, Bangalore,
Karnataka, India.

Rheum emodi (Rhubarb): A Fascinating Herb

Hina Rehman, Wajeעה Begum, Farzana Anjum, Humyra Tabasum

ABSTRACT

Rheum emodi or Himalayan rhubarb is a perennial herb belongs to family Polygonaceae. It has been used in various traditional systems as laxative, tonic, diuretic and to treat fever, cough, indigestion, menstrual disorder since antiquity. This paper consists of literature of *Rheum emodi* regarding its ethnobotany, folkloric uses, chemical properties and pharmacological studies. The material was collected from journals and books via library and electronic search. The most common constituents of *Rheum emodi* are anthraquinone (rhein, chrysophanol, aloe-emodin, emodin, physcion, and their glycosides) and stilbene (picetannol, resveratrol and their glycosides). Studies have shown that *Rheum emodi* possess anticancer, antioxidant, anti-inflammatory, antimicrobial, antifungal, antidiyslipidemic, antiplatelet, antidiabetic, antiulcer, hepatoprotective, immunoenhancing and nephroprotective activities. These studies raised the therapeutic efficacy of rhubarb in diverse ailments. It is essential that this drug should studied more extensively to confirm these therapeutic effects and to validate traditional uses.

Keywords: *Rheum emodi*; phytochemistry; antiulcer; antidiyslipidemic; hepatoprotective; antioxidant.

1. Introduction

Plants have serve mankind since centuries as they contain secondary metabolites that exert specific therapeutic effects. Rhubarb is commonly used worldwide herb and often known as "the wondrous drug" because of its extensive medicinal uses^[1]. It consists of dried rhizome and root of some rheum species and their hybrid of family polygonaceae. The genus *Rheum* consists of approximately 60 perennial species distribution around the world; several species are used in medicine, some for culinary purpose and few others are grown as ornament; about ten species occur in India^[2-3]. Rhubarb contains a variety of compounds like flavonoids, anthraquinone glycosides, tannins, volatile oils and saponins^[4-5] and has long been used as an ingredient of purgative, laxative and stomachic^[3]. Paradoxically, although larger doses were used as a laxative, small dose were used to treat dysentery and diarrhea^[6]. Rhubarb has also been used in jams, jelly and sauce by its tart flavor^[7]. There are three main types of rhubarbs, viz. the Chinese Rhubarb, the Indian Rhubarb, and the Rhapontic Rhubarb^[3]. Chinese Rhubarb comprises of dried rhizomes of *Rheum palmatum* L., and *Rheum officinale* Bail^[6]. *Rheum emodi*, commonly known as Indian or Himalayan Rhubarb, is official in Indian Pharmacopeia^[8].

2. Historical Overview

The use of this drug has been traced in medicine from very early time. The Chinese appear to have been acquainted with the properties of Rhubarb from a period long anterior to Christian era around 2700BC^[9]. It was first documented in "The Shen Nong Ben Cao Jing", the earliest book on materia medica in the world^[10]. It was being imported in Greece and Rome for medicinal purposes in the 1st century. Dioscorides and Galen described the good medicinal properties of rhubarb in their manuscripts and Avicenna has quoted the use of rhubarb in almost all system of body^[7, 11-13]. By the 10th century this root became a major export of Asia^[14] and gradually spreads to India, Russia, Europe and North America. In Europe it was much price drug even more than opium and in France (in 1542) it was sold for ten times the price of cinnamon and four times that of saffron^[7, 14].

3. Etymology of Rhubarb

The word rhubarb has been derived from Latin word "rha" (river) and "barb" (barbarian land). In ancient times, rhubarb roots were imported by Romans from barbarian lands which were beyond the Volga or Rha River. Imported from barbarians across the Rha, the plant became Rhabarbarum^[7, 11]. According to Lindley's Treasury of Botany, some authorities derive the name from the Greek *rheo* ('to flow'), in allusion to the purgative properties of the root^[15].

4. Plant description

4.1 Vernaculars

Rheum emodi or Himalayan rhubarb is known by various

vernacular names in different geographical regions or system. Detail is mentioned in Table 1.

Table 1: Vernaculars or *Rheum emodi*

Language/System	Name
English	Indian Rhubarb or Himalayan Rhubarb ^[16]
Sanskrit	Gandhini, Revatchini Hindi Dolu ^[3] , Pita ^[18]
Kashmiri	Pumbehakh ^[17]
Tamil	Nattu-ireval-chini, Nattu-manjal-chinni-kizhangu ^[18]
Telgu	Nattu-revalchini ^[16]
Arabic	Reward ^[18]
Persian	Rewardchini ^[18]
Ayurvedic	Amlaparni, pitamuuli, Gandhini Revatikka ^[19]
Siddha	Revalchinikattai, Nattirevaichini ^[19]
Unani	Revandchini ^[17] .
Synonym Rheum austral D. Don ^[19]	

4.2 Occurrence and distribution

Rheum emodi is a stout herb, endemic to the Himalayan region distributed in the temperate and subtropical region from Kashmir to Sikkim at an elevation of 2800-3000m in India. It grows in the alpine zone on rocky soils, moraines and cervices ^[20].

4.3 Botanical description

Rheum emodi Wall.exMeissn, is a leafy perennial herb ^[21], 1.5-3.0 m in height ^[3]. Roots very stout. Radical leaves long-petioled, very large, often 60 cm in diameter, orbicular or broadly ovate obtuse, base cordate 5-7 nerved, papillose beneath, subscaberulous above; petiole 30-45 cm, very stout, scaberulous. Panicle is 0.6-0.9 m, papillosoyly puberulous, fastigiatey branched and leafy with erect strict branches; flowers small 3 mm diameter, dark purple or pale red, in axillary panicles. Fruit ovoid-oblong, 13 mm long, purple, base cordate, apex notched, wings narrower than the disk ^[22].

Roots and rhizomes are the main parts used as drug and are collected in October to November. Root of Indian Rhubarb is darker, inferior in aroma, coarser and untrimmed, is not decorticated. Fresh rhizome is 6 to 12 inches long, and the freshly fractured surface is dull orange to yellowish brown ^[4].

5. Pharmacological actions and traditional uses

Rheum emodi is considered as purgative, stomachic, and astringent tonic ^[3, 16, 21]. It also possesses aperient, emmenagogue and diuretic properties ^[3, 21]. Root is regarded as expectorant and appetizer. Anti-inflammatory, anti-dysentery and alexentric actions have also been ascribed ^[21].

Rhubarb is widely used in various traditional systems such as, Unani, Ayurveda, Chinese etc. The uses of Rhubarb by Unani

scholars are described in Table 2.

Indian rhubarb is used as a purgative and astringent tonic. Its primary action is of mild purgation; but it has also astringent property, so that it's secondary effect is to confine the bowels, hence it is well fitted for use in simple diarrhoea, but not in constipation or any affection in which a continuous aperient action is necessary. It is useful remedy in ailments of children. For the errors in diet of children and for the diarrhoea set up by undigested food, it is best given combined with sodium bicarbonate or magnesia. Rhubarb forms an important ingredient of a large variety of compound. Combined with ginger it may be given in the form of pills in cases where the bowels are sluggish ^[16]. Root is regarded as panacea in local home remedies and is used in stomach problems, cuts, wound, and muscular swelling, tonsillitis and mumps ^[17]. Some persons chew the root, and to them this is a very good way of taking it ^[16]. Powdered roots are used for cleaning teeth and sprinkled over ulcers for quick healing ^[3]. Ethno-medically leaf-stalk, leaves and flowers are consumed as vegetables after cooking ^[23]. In Assam its leaves consumed as vegetables and cultivated for this purpose. Leaves are also dried and stored for consumption along with other foods, or made into a preserve. It is however stated that cook stalks act as a powerful purgative ^[3]. Besides the medicinal uses, it is also used for coloration of textile and wooden material ^[24].

6. Physicochemical study

Physicochemical study of *Rheum emodi* is carried out by Aslam *et al.* ^[4] The total ash value of the plant is recorded as 4% whereas, acid insoluble and water insoluble is found to be 0.6% and 2.6% respectively. Florescence analysis of *Rheum emodi* is mentioned below in the Table 3.

Table 2: Uses of Rhubarb

	Ailments	Approach
Urogenital system	Retention of urine	Rhubarb is taken along with seeds of <i>Cucumis melo</i> and <i>Tribulus terrestris</i> ^[11] .
	Dysmenorrhoea with oligomenorrhoea	Powdered rhubarb admixed is taken 2 days before menstruation and continue three days during menstruation ^[11] .
	Menorrhagia	Taken with juice of <i>Plantago major</i> and <i>Nardostachys jatamansi</i> ^[12] .
Gastrointestinal system	Jaundice	Rhubarb taken with decoction of root of <i>Foeniculum vulgare</i> , <i>Cichorium intybus</i> , <i>Capparis spinosa</i> and <i>Apium graveolens</i> ^[12] .
	Diarrhea	Taken with dried roses or pomegranate or gum of acacia ^[13] .
	Indigestion,	Alone or taken with <i>Aloe vera</i> and <i>Chebolic myrobalan</i> .
	Hiccough	Taken with aniseeds or lukewarm water ^[12] .
Respiratory system	Cough and asthma	Rhubarb is crushed and make pill with resins of quince ^[11] .
	Haemoptysis	Crush root is chewed and kept in mouth for some time ^[12] .
Nervous system	Headache, Migraine, Paralysis	Rhubarb is taken with <i>Chebolic myrobalan</i> and <i>Polyporus officinalis</i> and <i>Aloe vera</i> ^[11, 12] .
Musculoskeletal system	Bruises	Rhubarb together with <i>tila</i> (a preparation by grapes water) taken orally ^[13] .
	Muscular pain / body ache and arthritis ⁹	Externally rhubarb is recommended for hot swellings in combination with some liquid ^[12, 13] .
	Swelling and Inflammation	Oil of rhubarb is applied on affected part ^[13] . Its powder is also recommended for the management of abscess ^[11] .
	Abscess	Taken with decoction of asarum ^[12] .
Skin	Sciatica	
	Freckle and other skin marks. Melasma	Root is crushed and grinded and makes paste with vinegar and applied externally on affected part ^[11, 12, 13] . Powder of root is applied with fresh milk ^[11] .

Table 3: Florescence analysis of powder of crude drug with different agent

S.no	Treatment	Daylight	UV light (254nm)	UV light (366nm)
1.	Powder as such	Brown	Dark Brown	Brown
3.	1N NaOH	Reddish Brown	Brown	Reddish Brown
4.	HNO ₃	Light Yellowish Brown	Yellowish Brown	Greenish Brown
5.	H ₂ SO ₄	Blackish Brown	Yellow Brown	Greenish Brown
6.	Iodine	Blackish Brown	Greenish Yellow	Light Greenish Yellow
7.	Conc. HCl	Brown	Yellowish Green	Light Green
8.	Ferric Chloride	Yellowish Brown	Dark Yellowish Brown	Dark Yellow
9.	Ammonia	Blackish Green	Light Greenish Black	Dark Green
10.	Glacial Acetic acid	Light Brown	Brown	Light Yellowish Brown
11.	Picric acid	Brown	Light Yellow	Greenish Yellow

7. Phytochemistry

Rheum emodi possess a number of phytoconstituents and these are: anthraquinones, anthrones, stilbenes, oxanthrone ethers and esters, flavonoids, lignans, phenols, carbohydrate and oxalic acid ^[23]. The most common constituents of *Rheum emodi* are anthraquinone and stilbene. Anthraquinones include rhein, chrysophanol, aloemodin, emodin, physcion (emodin monomethyl ether), chrysophanein and emodin glycoside.

Stilbene includes picetannol, resveratrol and their glycosides ^[25]. Different derivatives of oxanthrone include oxanthrone ether (revandchinone-4), oxanthrone esters (revandchinone-1 and revandchinone-2), and revandchinone-3 ^[26-27]. Other complex compounds have also been reported, including torachryson 8-O-b-D-glucoside, sulfated anthraquinone glycoside sulfemodin 8-O-b-D-glucoside b-asarone and rhein 11-O-b-D-glucoside ^[28]. Tannins are also present in rhubarb

which includes hydrolysable tannins, containing ester or glycosidic bonds composed of gallic acid, glucose and other monosaccharides and condensed tannins, derived primarily from the flavone derivatives catechin and leucocyanidin ^[4].

8. Pharmacological studies

Recent studies have showed that *Rheum emodi* possess anticancer, antioxidant, antidiabetic, antifungal, antiulcer along with hepatoprotective and nephroprotective properties and these action are due to a number of compounds isolated from it.

8.1 Anticancer activity

Rajkumar *et al.* tested the methanolic and aqueous extracts of the *Rheum emodi* rhizome in human breast carcinoma (MDA-MB-435S) and liver carcinoma (Hep3B) cell lines for cytotoxicity. They found that the extracts exhibited extensive concentration-dependent cytotoxicity in tested cells ^[21,29].

8.2 Antidiabetic effect

Radhika *et al.* carried out a study to evaluate the antidiabetic effect of *Rheum emodi* rhizome extract and to study the activities of hexokinase, aldolase and phosphoglucosomerase, and gluconeogenic enzymes such as glucose-6-phosphatase and fructose-1, 6-diphosphatase in liver and kidney of normal and alloxan induced diabetic rats. Oral administration of 75 % ethanolic extract (250 mg/kg body weight) for 30 days, resulted in decrease in the activities of glucose-6-phosphatase, fructose-1, 6-diphosphatase, aldolase and an increase in the activity of phosphoglucosomerase and hexokinase in tissues ^[20]. Radhika *et al.* also investigated therapeutic effects of *Rheum emodi* rhizome extract in another study on certain biochemical marker like aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and LDH in the serum, liver and kidney tissue in alloxan – induced diabetes mellitus in rats. They have found that 250 mg/kg oral administration of *Rheum emodi* rhizome extract of 75% ethanolic extract to diabetic rat for 30 days restored all marker enzymes to near control level ^[30].

8.3 Antidyslipidemic activity

Ethanolic extract of *Rheum emodi* shown antidyslipidemic effect in a study conducted by Mishra *et al.* Chrysophanol, emodin, chrysophanol 8-O- β -D-glucopyranoside and emodin 8-O- β -D-glucopyranoside were active constituents and has significant effect in triton induced rats by reducing plasma lipids level. Emodin showed significant lipid lowering activity in high fed diet model ^[31].

8.4 Antifungal activity

Rhein, physcion, aloe-emodin and chrysophanol isolated from *Rheum emodi* rhizomes exhibited antifungal activity against *Candida albicans*, *Cryptococcus neoformans*, *Trichophyton mentagrophytes* and *Aspergillus fumigatus* (MIC 25-250 μ g/ml) responsible for skin diseases in India ^[32]. In a different experiment, three compounds isolated from the *Rheum emodi* rhizome (revandchinone-1, 3 and 4) exhibited antifungal activity against *Aspergillus niger* and *Rhizopus oryzae*, with inhibition zone diameters of 8-9 and 9-11 mm for the 100 and 150 g/ml test concentrations, respectively ^[26].

8.5 Anti-inflammatory activity

Chauhan *et al.* studied the anti-inflammatory activity of the

methanol extract of the rhizome (500 mg/kg). The anti-inflammatory activity was evaluated by using carrageenan-induced paw oedema. It was found that the degree of inhibition of oedema increased with time, reaching maximum inhibition after 5 h. This inhibitory activity was comparable to the control drug Ibuprofen (50 mg/kg body weight) ^[25].

8.6 Antimicrobial activity

Antimicrobial activity compound of *Rheum emodi* was investigated by Babu *et al.* Compounds were tested against gram positive (*Bacillus subtilis*, *Bacillus sphaericus* and *Staphylococcus aureus*) and gram negative (*Klebsiella aerogenes*, *Chromobacterium violaceum* and *Pseudomonas aeruginosa*) bacteria. Revandchinone-1 and 3 had lower degrees of antibacterial activity (inhibition zone diameters of 7–9 mm for the 30 and 100 g/ml test concentrations) than didrevandchinone-4 (inhibition zone diameter of 12–14 mm at both the 30 and 100 g/ml test concentrations) ^[26].

8.7 Antioxidant activity

The 2,2-diphenyl-1-picrylhydrazyl (DPPH) and hydroxyl radical scavenging activities, inhibitory effects on lipid peroxidation (LPI) and Fe³⁺ reducing antioxidant properties of methanolic/aqueous extracts of the *Rheum emodi* rhizome were studied. Furthermore, the extracts proved to contain a high number of phenolic compounds, which were found to have strongly significant positive correlation with free radicals (DPPH and OH) scavenging efficacies, percentages of LPI and Fe³⁺ reductions ^[21].

8.8 Antiplatelet and Anticoagulant activities

Seo EJ *et al.* investigated the effects of anthraquinone derivatives isolated from rhubarb on platelet activity. Of four anthraquinone derivatives isolated from rhubarb examined, chrysophanol-8-O-glucoside (CP- 8-O-glc) was found to have the most potent inhibitory effect on collagen- and thrombin-induced platelet aggregation. CP-8-O-glc-treated mice showed significantly prolonged bleeding times. Furthermore, CP-8-O-glc was found to have a significant inhibitory effect on rat platelet aggregation *ex vivo* and on thromboxane A₂ formation *in vitro* ^[33].

8.9 Antiulcer activity

Antiulcer effect of ethanolic extract of rhizome of *Rheum emodi* was investigated on pyloric ligation-induced ulcers in rats by Amandeep *et al.* It was found that there is reduction in ulcer index along with the reduction in volume and total acidity, and an increase in the pH of gastric fluid ^[34].

8.10 Hepatoprotective activity

The hepatoprotective activity of the ethanolic extracts of *Rheum emodi* rhizome against CCl₄-induced liver damage in Wistar rats has been evaluated by Ibrahim *et al.* Carbon tetrachloride administration caused a significant increase in the serum activities of AST, ALT and ALP and a similar increase in the total bilirubin. Oral administration of *Rheum emodi* at 3.0 g/kg significantly decreased the above elevated parameters, and the normal structure of the liver pattern was restored ^[8]. Other similar study by Akhtar *et al.* has confirmed the hepatoprotective effect of aqueous extract of *Rheum emodi* against liver damage induced by paracetamol in albino rats ^[35].

8.11 Immune-enhancing effect

Konsar F *et al.* studied the immune-enhancing activity from ethyl acetate rhizome extract of *Rheum emodi* on the cell lines and it found to have an immune-enhancing effect through the release of various cytokines. There is a dose-dependent increase in the release of NO (Nitric Oxide) and cytokines TNF- α , IL-12, and a decrease in IL-10 by RAW 264.7 in macrophages cell line in the presence of extract alone ^[36].

8.12 Nephroprotective effect

The renal effects of water-soluble (W-S) and water-insoluble (W-INS) portions of the alcoholic extract of *Rheum emodi* were investigated on cadmium chloride, mercuric chloride, potassium dichromate and gentamicin-induced nephrotoxicity in rats and normal rats by monitoring the levels of urea nitrogen and creatinine in serum. W-S fraction has nephroprotective effect on all the proximal tubule segments (S₁, S₂ and S₃) possibly through antioxidant action of the tannins present in the fraction ^[37].

9. Contraindications

Its use is prohibited for the patients suffering from gout, rheumatism, epilepsy and uric acid troubles, for people with a history of renal or gall bladder stones ^[3, 16]. The rhizome contains some oxalic acid, which, when consumed, can combine with calcium in the blood to form insoluble calcium oxalate crystals that may be deposited in the kidneys or gall bladder. It is not fitted for inflammatory or febrile cases although it seldom act as irritant. When given internally, the roots impart a deep tinge to urine ^[16].

10. Conclusion

The above literature shown that *Rheum emodi* is an herb of enormous therapeutic effects and has been used in numerous ailments specially for constipation, indigestion, diarrhea, muscular pain, skin problems and menstrual disorder and. A number of compounds are isolated from it; anthraquinones and stilbenes are the most common which are responsible for its extensive use. Further studies are required to isolate other biological active constituents responsible for its therapeutic use and also to validate the traditional knowledge of rhubarb.

11. Acknowledgement

Authors are thankful to Dr. Alia Bilal, Department of Ilmul Advia (Pharmacology) for their valuable suggestions in writing the manuscript.

12. References

1. Foust MC. Rhubarb: The Wondrous Drug. N Engl J Med. 1993; 328:215.
2. Rokaya MB, Marsik P, Münzbergová Z. Active constituents in *Rheum acuminatum* and *Rheum australe* (Polygonaceae) roots: A variation between cultivated and naturally growing plants. Biochemical Systematics and Ecology 2012; 41:83-90.
3. Anonymous. The Wealth of India. Vol. IX. New Delhi: National Institute of Science Communication and Resources; 2003. 3-4.
4. Aslam M, Dayal R, Javed K, Fahamiya N, Mohd Mujeeb, Husain A. Pharmacognostical and Phytochemical Evaluation of *Rheum emodi* Wall. Current Pharma Research 2012; 2(2):471-479.
5. Ye M, Han J, Chen H, Zheng J, Guo D. Analysis of Phenolic Compounds in Rhubarbs Using Liquid Chromatography Coupled with Electrospray Ionization Mass Spectrometry. J Am Soc Mass Spectrom 2007; 18:82–91.
6. Qin Y, Wang J, Kong W, Zhao Y, Yang H, Dai C *et al.* The diarrhoeogenic and anti-diarrhoeal bidirectional effects of rhubarb and its potential mechanism. Journal of Ethnopharmacology 2011; 133:1096–1102.
7. Prior M. Rhubarbaria recipes for rhubarb. Prospect books; 2009, 12.
8. Ibrahim M, Khaja NM, Aara A, Khan AA, Habeeb MA, Devi PY *et al.* Hepatoprotective activity of *Sapindus mukorossi* and *Rheum emodi* extracts. World J Gastroenterol 2008; 14(16):2566–2571.
9. Dymock W, Warden CJH, Hooper D. Pharmacographica Indica. A history of the principal drugs of vegetable origin. Vol III. New Delhi: Shrishti Book Distributors; 2005, 153-157.
10. Fanga F, Wanga J, Zhao Y, Cheng Jin, Konga W, Zhao H, *et al.* A comparative study on the tissue distributions of rhubarb anthraquinones in normal and CCl₄-injured rats orally administered rhubarb extract. Journal of Ethnopharmacology 2011; 137:1492–1497.
11. Najmul Ghani, Khazianul Advia. Lucknow: Munshi Naval Kishore Press; YNM. 750-753.
12. Ibn Baitar. Jami al Mufradat al Advia wa al Aghzia (Urdu Translation). Vol II. New Delhi: CCRUM; 2000, 275-282.
13. Ibn Sina. Al Qanoon Fil Tib (Urdu trans. by Kantoori GH). New Delhi: Ejaz Publication house; 2010, 447-48.
14. Elaine L. Rhubarb: A Brief History of Rhubarb in Britain About.com Guide. <http://britishfood.about.com/od/introtobritishfood/ss>. [Access date:03.07.2012]
15. The Rhubarb compendium. <http://www.rhubarbinfo.com/history> [Access date: 27.06.2012].
16. Nadkarni KM. Indian Plants and Drugs. New Delhi: Srishti Book Distributors; 2009.p. 1056-58.
17. Medicinal plants in folklores of Kashmir Himalayas. 1sted. New Delhi: CCRUM; 2001,184.
18. Anonymous. The Unani Pharmacopoeia of India. Part I. Vol II. New Delhi: Govt. of India Ministry of Health & Family Welfare Dept. of AYUSH; 2007.p 91-92.
19. Khare CP. Indian Medicinal Plants: An Illustrated Dictionary. New Delhi: Springer India (P) Ltd; 2007: 543-44.
20. Radhika R, Krishna kumara, Sudarsanam D. Antidiabetic activity of *Rheum emodi* in Alloxan induced diabetic rats. International Journal of Pharma Sciences and Research 2010; 1(8):296-300.
21. Rajkumar V, Guha G, Kumar RA. Antioxidant and Anti-Cancer Potentials of *Rheum emodi* Rhizome Extract. Evidenced-Based Complementary and Alternative Medicine 2011 June; 1-9.
22. Kirtikar KR, Basu BD. Indian Medicinal Plants with Illustrations. 2nd ed. Vol IX. Uttaranchal: 2003: 2907-10. Nadkarni KM. Indian Plants and Drugs. New Delhi: Srishti Book Distributors; 2009: 1056-58.

23. Parvaiz A, Wani, Irshad A, Nawchoo and B.A. Wafai. The Role of Phenotypic Plasticity, Phenology, Breeding Behaviour and Pollination Systems in Conservation of *Rheum emodi* Wall. exMeissn. (Polygonaceae) — A Threatened Medicinal Herb of North West Himalaya. The International Journal of Plant Reproductive Biology 2009; 1(2):179-189,
24. Das D. Colouration of wool and silk with *Rheum emodi*. Indian Journal of Fibre & Textile Research 2008; 33:163-170
25. Malik S, Sharma N, Sharma UK, Singh NP, Bhushan S, Sharma M *et al*. Qualitative and quantitative analysis of anthraquinone derivatives in rhizomes of tissue culture-raised *Rheum emodi* Wall. Plants Journal of Plant Physiology 2010; 167(9):749–756.
26. Babu KS, Srinivas PV, Praveen B, Kishore KH, Murty US, Rao JM. Antimicrobial constituents from the rhizomes of *Rheum emodi*. Phytochemistry 2003; 62:203–207.
27. Singh SS, Pandey SS, Singh R, Aggarwal S. 1, Dihydroxyanthraquinone Derivates from the Rhizome of *Rheum emodi* wall. Indian Journal of Chemistry 2005; 42B:1494-1496.
28. Krenn L, Pradhan R, Presser A, Reznicek G, Kopp B. Anthrone C-Glucosides from *Rheum emodi*. Chem Pharm Bull 2004; 52(4):391-393.
29. Rajkumar V, Guha G, Kumar RA. Apoptosis Induction in MDA-MB-435S, Hep3B and PC-3 Cell Lines by *Rheum emodi* Rhizome Extracts. Asian Pacific Journal of Cancer Prevention 2011; 12:1197-1200.
30. Radhika R, Ragavan B, Pawar SD, Sudarsanam D. Action of Marker enzymes of *Rheum emodi* in Alloxane induced Diabetic Rats. Asian J ExpBiol Sci 2012; 3(2):420-423.
31. Mishra SK, Tiwari S, Shrivastava A, Srivastava S, Boudh GK, Chourasia SK. Antidyslipidemic effect and antioxidant activity of anthraquinone derivatives from *Rheum emodi* rhizomes in dyslipidemic rats. J Nat Med 2013; Dec 17.
32. Agarwal SK, Sudhir SS, Sushma V, Kumar S. Antifungal activity of anthraquinone derivatives from *Rheum emodi*. Journal of Ethnopharmacology 2000; 72(1-2):43-46.
33. Seo EJ, Ngoc TM, Lee SM, Kim YS, Jung YS. Chrysophanol-8-*O*-glucoside, an Anthraquinone Derivative in Rhubarb, Has Antiplatelet and Anticoagulant Activities. J Pharmacol Sci 2012; 118: 245-254.
34. Kaur A, Kumar S, Sharma R. Assessment of Anti-Ulcer Activity of *Rheum emodi* Rhizomes Extract. Indo Global Journal of Pharmaceutical Sciences 2012; 2(3): 333-341.
35. Akhtar MS, Amin M, Ahmad M, Alamgeer. Hepatoprotective Effect of *Rheum emodi* Roots (*Revandchini*) and *Akseer-e-Jigar* Against Paracetamol-induced Hepatotoxicity in Rats. Ethnobotanical Leaflets 2009; 13:310-315.
36. Kausar F, Rather MA, Ghani BA, Zargar MA. Immune-enhancing effects of the herbal extract from Himalayan Rhubarb *Rheum emodi* Wall. Ex Meissn Food Chemistry 2011 June; 126(3):967-71.
37. Alam MMA, Javed K, Jafri MA. Effect of *Rheum emodi* (Revand Hindi) on renal functions in rats. Journal of Ethnopharmacology 2005; 96:121–125.